



#3

SEQUENCE LISTING

<110> Hong Jin et al.

<120> Recombinant RSV Expression Systems and  
Vaccines

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<140> 09/923,070

<141> 2001-08-06

<150> 09/161,122

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 50 55 60  
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 65 70 75 80  
 Leu Glu Glu Pro Thr Tyr Phe Gln Ser Leu Leu Met Thr Tyr Lys Ser  
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 Ile Arg Arg Ala Ile Glu Ile Ser Asp Val Lys Val Tyr Ala Ile Leu  
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|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Asn | Lys | Leu | Gly | Leu | Lys | Glu | Lys | Asp | Lys | Ile | Lys | Ser | Asn | Asn | Gly |
| 130 |     |     |     |     |     | 135 |     |     |     |     | 140 |     |     |     |     |
| Gln | Asp | Glu | Asp | Asn | Ser | Val | Ile | Thr | Thr | Ile | Ile | Lys | Asp | Asp | Ile |
| 145 |     |     |     |     | 150 |     |     |     |     | 155 |     |     |     |     | 160 |
| Leu | Ser | Ala | Val | Lys | Asp | Asn | Gln | Ser | His | Leu | Lys | Ala | Asp | Lys | Asn |
|     |     |     |     | 165 |     |     |     |     | 170 |     |     |     |     | 175 |     |
| His | Ser | Thr | Lys | Gln | Lys | Asp | Thr | Ile | Lys | Thr | Thr | Leu | Leu | Lys | Lys |
|     |     |     | 180 |     |     |     |     | 185 |     |     |     |     | 190 |     |     |
| Leu | Met | Cys | Ser | Met | Gln | His | Pro | Pro | Ser | Trp | Leu | Ile | His | Trp | Phe |
|     | 195 |     |     |     |     |     | 200 |     |     |     |     | 205 |     |     |     |
| Asn | Leu | Tyr | Thr | Lys | Leu | Asn | Asn | Ile | Leu | Thr | Gln | Tyr | Arg | Ser | Asn |
| 210 |     |     |     |     |     | 215 |     |     |     |     | 220 |     |     |     |     |
| Glu | Val | Lys | Asn | His | Gly | Phe | Thr | Leu | Ile | Asp | Asn | Gln | Thr | Leu | Ser |
| 225 |     |     |     |     | 230 |     |     |     |     | 235 |     |     |     |     | 240 |
| Gly | Phe | Gln | Phe | Ile | Leu | Asn | Gln | Tyr | Gly | Cys | Ile | Val | Tyr | His | Lys |
|     |     |     |     | 245 |     |     |     |     | 250 |     |     |     |     | 255 |     |
| Glu | Leu | Lys | Arg | Ile | Thr | Val | Thr | Thr | Tyr | Asn | Gln | Phe | Leu | Thr | Trp |
|     |     |     | 260 |     |     |     |     | 265 |     |     |     |     | 270 |     |     |
| Lys | Asp | Ile | Ser | Leu | Ser | Arg | Leu | Asn | Val | Cys | Leu | Ile | Thr | Trp | Ile |
|     | 275 |     |     |     |     |     | 280 |     |     |     |     | 285 |     |     |     |
| Ser | Asn | Cys | Leu | Asn | Thr | Leu | Asn | Lys | Ser | Leu | Gly | Leu | Arg | Cys | Gly |
| 290 |     |     |     |     |     | 295 |     |     |     |     | 300 |     |     |     |     |
| Phe | Asn | Asn | Val | Ile | Leu | Thr | Gln | Leu | Phe | Leu | Tyr | Gly | Asp | Cys | Ile |
| 305 |     |     |     |     | 310 |     |     |     |     | 315 |     |     |     |     | 320 |
| Leu | Lys | Leu | Phe | His | Asn | Glu | Gly | Phe | Tyr | Ile | Ile | Lys | Glu | Val | Glu |
|     |     |     |     | 325 |     |     |     |     | 330 |     |     |     |     | 335 |     |
| Gly | Phe | Ile | Met | Ser | Leu | Ile | Leu | Asn | Ile | Thr | Glu | Glu | Asp | Gln | Phe |
|     |     |     | 340 |     |     |     |     | 345 |     |     |     |     | 350 |     |     |
| Arg | Lys | Arg | Phe | Tyr | Asn | Ser | Met | Leu | Asn | Asn | Ile | Thr | Asp | Ala | Ala |
|     | 355 |     |     |     |     |     | 360 |     |     |     |     | 365 |     |     |     |
| Asn | Lys | Ala | Gln | Lys | Asn | Leu | Leu | Ser | Arg | Val | Cys | His | Thr | Leu | Leu |
| 370 |     |     |     |     |     | 375 |     |     |     |     | 380 |     |     |     |     |
| Asp | Lys | Thr | Val | Ser | Asp | Asn | Ile | Ile | Asn | Gly | Arg | Trp | Ile | Ile | Leu |
| 385 |     |     |     |     | 390 |     |     |     |     | 395 |     |     |     |     | 400 |
| Leu | Ser | Lys | Phe | Leu | Lys | Leu | Ile | Lys | Leu | Ala | Gly | Asp | Asn | Asn | Leu |
|     |     |     |     | 405 |     |     |     |     | 410 |     |     |     |     | 415 |     |
| Asn | Asn | Leu | Ser | Glu | Leu | Tyr | Phe | Leu | Phe | Arg | Ile | Phe | Gly | His | Pro |
|     |     |     | 420 |     |     |     |     | 425 |     |     |     |     | 430 |     |     |
| Met | Val | Asp | Glu | Arg | Gln | Ala | Met | Asp | Ala | Val | Lys | Ile | Asn | Cys | Asn |
|     | 435 |     |     |     |     |     | 440 |     |     |     |     | 445 |     |     |     |
| Glu | Thr | Lys | Phe | Tyr | Leu | Leu | Ser | Ser | Leu | Ser | Met | Leu | Arg | Gly | Ala |
| 450 |     |     |     |     |     | 455 |     |     |     |     | 460 |     |     |     |     |
| Phe | Ile | Tyr | Arg | Ile | Ile | Lys | Gly | Phe | Val | Asn | Asn | Tyr | Asn | Arg | Trp |
| 465 |     |     |     |     | 470 |     |     |     |     | 475 |     |     |     |     | 480 |
| Pro | Thr | Leu | Arg | Asn | Ala | Ile | Val | Leu | Pro | Leu | Arg | Trp | Leu | Thr | Tyr |
|     |     |     |     | 485 |     |     |     |     | 490 |     |     |     |     | 495 |     |
| Tyr | Lys | Leu | Asn | Thr | Tyr | Pro | Ser | Leu | Leu | Glu | Leu | Thr | Glu | Arg | Asp |
|     |     |     | 500 |     |     |     |     | 505 |     |     |     |     | 510 |     |     |
| Leu | Ile | Val | Leu | Ser | Gly | Leu | Arg | Phe | Tyr | Arg | Glu | Phe | Arg | Leu | Pro |
|     | 515 |     |     |     |     |     | 520 |     |     |     |     | 525 |     |     |     |
| Lys | Lys | Val | Asp | Leu | Glu | Met | Ile | Ile | Asn | Asp | Lys | Ala | Ile | Ser | Pro |
| 530 |     |     |     |     |     | 535 |     |     |     |     | 540 |     |     |     |     |
| Pro | Lys | Asn | Leu | Ile | Trp | Thr | Ser | Phe | Pro | Arg | Asn | Tyr | Met | Pro | Ser |
| 545 |     |     |     |     | 550 |     |     |     |     | 555 |     |     |     |     | 560 |
| His | Ile | Gln | Asn | Tyr | Ile | Glu | His | Glu | Lys | Leu | Lys | Phe | Ser | Glu | Ser |
|     |     |     | 565 |     |     |     |     | 570 |     |     |     |     |     | 575 |     |
| Asp | Lys | Ser | Arg | Arg | Val | Leu | Glu | Tyr | Tyr | Leu | Arg | Asp | Asn | Lys | Phe |
|     |     |     | 580 |     |     |     |     | 585 |     |     |     |     | 590 |     |     |

8



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 Thr Ser Glu Ile Asn Arg Leu Ala Val Thr Glu Val Leu Ser Thr Ala  
 1075 1080 1085  
 Pro Asn Lys Ile Phe Ser Lys Ser Ala Gln His Tyr Thr Thr Thr Glu  
 1090 1095 1100  
 Ile Asp Leu Asn Asp Ile Met Gln Asn Ile Glu Pro Thr Tyr Pro His  
 1105 1110 1115 1120  
 Gly Leu Arg Val Val Tyr Glu Ser Leu Pro Phe Tyr Lys Ala Glu Lys  
 1125 1130 1135  
 Ile Val Asn Leu Ile Ser Gly Thr Lys Ser Ile Thr Asn Ile Leu Glu  
 1140 1145 1150  
 Lys Thr Ser Ala Ile Asp Leu Thr Asp Ile Asp Arg Ala Thr Glu Met  
 1155 1160 1165  
 Met Arg Lys Asn Ile Thr Leu Leu Ile Arg Ile Leu Pro Leu Asp Cys  
 1170 1175 1180  
 Asn Arg Asp Lys Arg Glu Ile Leu Ser Met Glu Asn Leu Ser Ile Thr  
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 Glu Leu Ser Lys Tyr Val Arg Glu Arg Ser Trp Ser Leu Ser Asn Ile  
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 Val Gly Val Thr Ser Pro Ser Ile Met Tyr Thr Met Asp Ile Lys Tyr  
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 Thr Thr Ser Thr Ile Ser Ser Gly Ile Ile Ile Glu Lys Tyr Asn Val  
 1235 1240 1245  
 Asn Ser Leu Thr Arg Gly Glu Arg Gly Pro Thr Lys Pro Trp Val Gly  
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 Ser Ser Thr Gln Glu Lys Lys Thr Met Pro Val Tyr Asn Arg Gln Val  
 1265 1270 1275 1280  
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 1285 1290 1295  
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 Ser Ile Gly Thr Leu Gly Leu Thr Tyr Glu Lys Ala Lys Lys Leu Phe  
 1315 1320 1325  
 Pro Gln Tyr Leu Ser Val Asn Tyr Leu His Arg Leu Thr Val Ser Ser  
 1330 1335 1340  
 Arg Pro Cys Glu Phe Pro Ala Ser Ile Pro Ala Tyr Arg Thr Thr Asn  
 1345 1350 1355 1360  
 Tyr His Phe Asp Thr Ser Pro Ile Asn Arg Ile Leu Thr Glu Lys Tyr  
 1365 1370 1375  
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| Gly Tyr Ile Thr Asp His Met Phe Ile Asn Leu Lys Val Phe Phe Asn |      |      |      |
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| Ala Tyr Lys Thr Tyr Leu Leu Cys Phe His Lys Gly Tyr Gly Lys Ala |      |      |      |
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| Lys Leu Glu Cys Asp Met Asn Thr Ser Asp Leu Leu Cys Val Leu Glu |      |      |      |
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| Leu Ile Asp Ser Ser Tyr Trp Lys Ser Met Ser Lys Val Phe Leu Glu |      |      |      |
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| Gln Lys Val Ile Lys Tyr Ile Leu Ser Gln Asp Ala Ser Leu His Arg |      |      |      |
| 1585  | 1590 | 1595 | 1600 |
| Val Lys Gly Cys His Ser Phe Lys Leu Trp Phe Leu Lys Arg Leu Asn |      |      |      |
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| Val Ala Glu Phe Thr Val Cys Pro Trp Val Val Asn Ile Asp Tyr His |      |      |      |
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| Pro Thr His Met Lys Ala Ile Leu Thr Tyr Ile Asp Leu Val Arg Met |      |      |      |
|   | 1635 | 1640 | 1645 |
| Gly Leu Ile Asn Ile Asp Arg Ile His Ile Lys Asn Lys His Lys Phe |      |      |      |
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| Asn Asp Glu Phe Tyr Thr Ser Asn Leu Phe Tyr Ile Asn Tyr Asn Phe |      |      |      |
| 1665  | 1670 | 1675 | 1680 |
| Ser Asp Asn Thr His Leu Leu Thr Lys His Ile Arg Ile Ala Asn Ser |      |      |      |
|   | 1685 | 1690 | 1695 |
| Glu Leu Glu Asn Asn Tyr Asn Lys Leu Tyr His Pro Thr Pro Glu Thr |      |      |      |
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| Leu Glu Asn Ile Leu Ala Asn Pro Ile Lys Ser Asn Asp Lys Lys Thr |      |      |      |
|   | 1715 | 1720 | 1725 |
| Leu Asn Asp Tyr Cys Ile Gly Lys Asn Val Asp Ser Ile Met Leu Pro |      |      |      |
|   | 1730 | 1735 | 1740 |
| Leu Leu Ser Asn Lys Lys Leu Ile Lys Ser Ser Ala Met Ile Arg Thr |      |      |      |
| 1745  | 1750 | 1755 | 1760 |
| Asn Tyr Ser Lys Gln Asp Leu Tyr Asn Leu Phe Pro Met Val Val Ile |      |      |      |
|   | 1765 | 1770 | 1775 |
| Asp Arg Ile Ile Asp His Ser Gly Asn Thr Ala Lys Ser Asn Gln Leu |      |      |      |
|   | 1780 | 1785 | 1790 |
| Tyr Thr Thr Thr Ser His Gln Ile Ser Leu Val His Asn Ser Thr Ser |      |      |      |
|   | 1795 | 1800 | 1805 |
| Leu Tyr Cys Met Leu Pro Trp His His Ile Asn Arg Phe Asn Phe Val |      |      |      |
|   | 1810 | 1815 | 1820 |
| Phe Ser Ser Thr Gly Cys Lys Ile Ser Ile Glu Tyr Ile Leu Lys Asp |      |      |      |
| 1825  | 1830 | 1835 | 1840 |
| Leu Lys Ile Lys Asp Pro Asn Cys Ile Ala Phe Ile Gly Glu Gly Ala |      |      |      |
|   | 1845 | 1850 | 1855 |
| Gly Asn Leu Leu Leu Arg Thr Val Val Glu Leu His Pro Asp Ile Arg |      |      |      |
|   | 1860 | 1865 | 1870 |
| Tyr Ile Tyr Arg Ser Leu Lys Asp Cys Asn Asp His Ser Leu Pro Ile |      |      |      |
|   | 1875 | 1880 | 1885 |
| Glu Phe Leu Arg Leu Tyr Asn Gly His Ile Asn Ile Asp Tyr Gly Glu |      |      |      |
|   | 1890 | 1895 | 1900 |
| Asn Leu Thr Ile Pro Ala Thr Asp Ala Thr Asn Asn Ile His Trp Ser |      |      |      |
| 1905  | 1910 | 1915 | 1920 |
| Tyr Leu His Ile Lys Phe Ala Glu Pro Ile Ser Leu Phe Val Cys Asp |      |      |      |
|   | 1925 | 1930 | 1935 |
| Ala Glu Leu Ser Val Thr Val Asn Trp Ser Lys Ile Ile Ile Glu Trp |      |      |      |
|   | 1940 | 1945 | 1950 |
| Ser Lys His Val Arg Lys Cys Lys Tyr Cys Ser Ser Val Asn Lys Cys |      |      |      |
|   | 1955 | 1960 | 1965 |
| Met Leu Ile Val Lys Tyr His Ala Gln Asp Asp Ile Asp Phe Lys Leu |      |      |      |
|   | 1970 | 1975 | 1980 |

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 Lys Gly Ser Glu Val Tyr Leu Val Leu Thr Ile Gly Pro Ala Asn Ile  
 2005 2010 2015  
 Phe Pro Val Phe Asn Val Val Gln Asn Ala Lys Leu Ile Leu Ser Arg  
 2020 2025 2030  
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 145 150 155 160  
 Leu Ser Ala Val Lys Asp Asn Gln Ser His Leu Lys Ala Asp Lys Asn  
 165 170 175  
 His Ser Thr Lys Gln Lys Asp Thr Ile Lys Thr Thr Leu Leu Lys Lys  
 180 185 190  
 Leu Met Cys Ser Met Gln His Pro Pro Ser Trp Leu Ile His Trp Phe  
 195 200 205  
 Asn Leu Tyr Thr Lys Leu Asn Asn Ile Leu Thr Gln Tyr Arg Ser Asn

|   |     |     |     |     |
|---|-----|-----|-----|-----|
| 210   |     | 215 |     | 220 |
| Glu Val Lys Asn His Gly Phe Thr Leu Ile Asp Asn Gln Thr Leu Ser |     |     |     |     |
| 225   |     | 230 |     | 240 |
| Gly Phe Gln Phe Ile Leu Asn Gln Tyr Gly Cys Ile Val Tyr His Lys |     |     |     |     |
|   | 245 |     | 250 | 255 |
| Glu Leu Lys Arg Ile Thr Val Thr Thr Tyr Asn Gln Phe Leu Thr Trp |     |     |     |     |
|   | 260 |     | 265 | 270 |
| Lys Asp Ile Ser Leu Ser Arg Leu Asn Val Cys Leu Ile Thr Trp Ile |     |     |     |     |
|   | 275 |     | 280 | 285 |
| Ser Asn Cys Leu Asn Thr Leu Asn Lys Ser Leu Gly Leu Arg Cys Gly |     |     |     |     |
|   | 290 |     | 295 | 300 |
| Phe Asn Asn Val Ile Leu Thr Gln Leu Phe Leu Tyr Gly Asp Cys Ile |     |     |     |     |
| 305   |     | 310 |     | 320 |
| Leu Lys Leu Phe His Asn Glu Gly Phe Tyr Ile Ile Lys Glu Val Glu |     |     |     |     |
|   | 325 |     | 330 | 335 |
| Gly Phe Ile Met Ser Leu Ile Leu Asn Ile Thr Glu Glu Asp Gln Phe |     |     |     |     |
|   | 340 |     | 345 | 350 |
| Arg Lys Arg Phe Tyr Asn Ser Met Leu Asn Asn Ile Thr Asp Ala Ala |     |     |     |     |
|   | 355 |     | 360 | 365 |
| Asn Lys Ala Gln Lys Asn Leu Leu Ser Arg Val Cys His Thr Leu Leu |     |     |     |     |
|   | 370 |     | 375 | 380 |
| Asp Lys Thr Val Ser Asp Asn Ile Ile Asn Gly Arg Trp Ile Ile Leu |     |     |     |     |
| 385   |     | 390 |     | 400 |
| Leu Ser Lys Phe Leu Lys Leu Ile Lys Leu Ala Gly Asp Asn Asn Leu |     |     |     |     |
|   | 405 |     | 410 | 415 |
| Asn Asn Leu Ser Glu Leu Tyr Phe Leu Phe Arg Ile Phe Gly His Pro |     |     |     |     |
|   | 420 |     | 425 | 430 |
| Met Val Asp Glu Arg Gln Ala Met Asp Ala Val Lys Ile Asn Cys Asn |     |     |     |     |
|   | 435 |     | 440 | 445 |
| Glu Thr Lys Phe Tyr Leu Leu Ser Ser Leu Ser Met Leu Arg Gly Ala |     |     |     |     |
|   | 450 |     | 455 | 460 |
| Phe Ile Tyr Arg Ile Ile Lys Gly Phe Val Asn Asn Tyr Asn Arg Trp |     |     |     |     |
| 465   |     | 470 |     | 480 |
| Pro Thr Leu Arg Asn Ala Ile Val Leu Pro Leu Arg Trp Leu Thr Tyr |     |     |     |     |
|   | 485 |     | 490 | 495 |
| Tyr Lys Leu Asn Thr Tyr Pro Ser Leu Glu Leu Thr Glu Arg Asp     |     |     |     |     |
|   | 500 |     | 505 | 510 |
| Leu Ile Val Leu Ser Gly Leu Arg Phe Tyr Arg Glu Phe Arg Leu Pro |     |     |     |     |
|   | 515 |     | 520 | 525 |
| Lys Lys Val Asp Leu Glu Met Ile Ile Asn Asp Lys Ala Ile Ser Pro |     |     |     |     |
|   | 530 |     | 535 | 540 |
| Pro Lys Asn Leu Ile Trp Thr Ser Phe Pro Arg Asn Tyr Met Pro Ser |     |     |     |     |
| 545   |     | 550 |     | 560 |
| His Ile Gln Asn Tyr Ile Glu His Glu Lys Leu Lys Phe Ser Glu Ser |     |     |     |     |
|   | 565 |     | 570 | 575 |
| Asp Lys Ser Arg Arg Val Leu Glu Tyr Tyr Leu Arg Asp Asn Lys Phe |     |     |     |     |
|   | 580 |     | 585 | 590 |
| Asn Glu Cys Asp Leu Tyr Asn Cys Val Val Asn Gln Ser Tyr Leu Asn |     |     |     |     |
|   | 595 |     | 600 | 605 |
| Asn Pro Asn His Val Val Ser Leu Thr Gly Lys Glu Arg Glu Leu Ser |     |     |     |     |
|   | 610 |     | 615 | 620 |
| Val Gly Arg Met Phe Ala Met Gln Pro Gly Met Phe Arg Gln Val Gln |     |     |     |     |
| 625   |     | 630 |     | 640 |
| Ile Leu Ala Glu Lys Met Ile Ala Glu Asn Ile Leu Gln Phe Phe Pro |     |     |     |     |
|   | 645 |     | 650 | 655 |
| Glu Ser Leu Thr Arg Tyr Gly Asp Leu Glu Leu Gln Lys Ile Leu Glu |     |     |     |     |
|   | 660 |     | 665 | 670 |
| Leu Lys Ala Gly Ile Ser Asn Lys Ser Asn Arg Tyr Asn Asp Asn Tyr |     |     |     |     |

|      |     |     |     |     |      |     |     |     |     |      |     |     |     |     |      |  |
|------|-----|-----|-----|-----|------|-----|-----|-----|-----|------|-----|-----|-----|-----|------|--|
| 675  |     |     |     |     | 680  |     |     |     |     | 685  |     |     |     |     |      |  |
| Asn  | Asn | Tyr | Ile | Ser | Lys  | Cys | Ser | Ile | Ile | Thr  | Asp | Leu | Ser | Lys | Phe  |  |
| 690  |     |     |     |     | 695  |     |     |     |     | 700  |     |     |     |     |      |  |
| Asn  | Gln | Ala | Phe | Arg | Tyr  | Glu | Thr | Ser | Cys | Ile  | Cys | Ser | Asp | Val | Leu  |  |
| 705  |     |     |     |     | 710  |     |     |     |     | 715  |     |     |     |     | 720  |  |
| Asp  | Glu | Leu | His | Gly | Val  | Gln | Ser | Leu | Phe | Ser  | Trp | Leu | His | Leu | Thr  |  |
| 725  |     |     |     |     | 730  |     |     |     |     | 735  |     |     |     |     |      |  |
| Ile  | Pro | His | Val | Thr | Ile  | Ile | Cys | Thr | Tyr | Arg  | His | Ala | Pro | Pro | Tyr  |  |
| 740  |     |     |     |     | 745  |     |     |     |     | 750  |     |     |     |     |      |  |
| Ile  | Gly | Asp | His | Ile | Val  | Asp | Leu | Asn | Asn | Val  | Asp | Glu | Gln | Ser | Gly  |  |
| 755  |     |     |     |     | 760  |     |     |     |     | 765  |     |     |     |     |      |  |
| Leu  | Tyr | Arg | Tyr | His | Met  | Gly | Gly | Ile | Glu | Gly  | Trp | Cys | Gln | Lys | Leu  |  |
| 770  |     |     |     |     | 775  |     |     |     |     | 780  |     |     |     |     |      |  |
| Trp  | Thr | Ile | Glu | Ala | Ile  | Ser | Leu | Leu | Asp | Leu  | Ile | Ser | Leu | Lys | Gly  |  |
| 785  |     |     |     |     | 790  |     |     |     |     | 795  |     |     |     |     | 800  |  |
| Lys  | Phe | Ser | Ile | Thr | Ala  | Leu | Ile | Asn | Gly | Asp  | Asn | Gln | Ser | Ile | Asp  |  |
| 805  |     |     |     |     | 810  |     |     |     |     | 815  |     |     |     |     |      |  |
| Ile  | Ser | Lys | Pro | Ile | Arg  | Leu | Met | Glu | Gly | Gln  | Thr | His | Ala | Gln | Ala  |  |
| 820  |     |     |     |     | 825  |     |     |     |     | 830  |     |     |     |     |      |  |
| Asp  | Tyr | Leu | Leu | Ala | Leu  | Asn | Ser | Leu | Lys | Leu  | Leu | Tyr | Lys | Glu | Tyr  |  |
| 835  |     |     |     |     | 840  |     |     |     |     | 845  |     |     |     |     |      |  |
| Ala  | Gly | Ile | Gly | His | Lys  | Leu | Lys | Gly | Thr | Glu  | Thr | Tyr | Ile | Ser | Arg  |  |
| 850  |     |     |     |     | 855  |     |     |     |     | 860  |     |     |     |     |      |  |
| Asp  | Met | Gln | Phe | Met | Ser  | Lys | Thr | Ile | Gln | His  | Asn | Gly | Val | Tyr | Tyr  |  |
| 865  |     |     |     |     | 870  |     |     |     |     | 875  |     |     |     |     | 880  |  |
| Pro  | Ala | Ser | Ile | Lys | Lys  | Val | Leu | Arg | Val | Gly  | Pro | Trp | Ile | Asn | Thr  |  |
| 885  |     |     |     |     | 890  |     |     |     |     | 895  |     |     |     |     |      |  |
| Ile  | Leu | Asp | Asp | Phe | Lys  | Val | Ser | Leu | Glu | Ser  | Ile | Gly | Ser | Leu | Thr  |  |
| 900  |     |     |     |     | 905  |     |     |     |     | 910  |     |     |     |     |      |  |
| Gln  | Glu | Leu | Glu | Tyr | Arg  | Gly | Glu | Ser | Leu | Leu  | Cys | Ser | Leu | Ile | Phe  |  |
| 915  |     |     |     |     | 920  |     |     |     |     | 925  |     |     |     |     |      |  |
| Arg  | Asn | Val | Trp | Leu | Tyr  | Asn | Gln | Ile | Ala | Leu  | Gln | Leu | Lys | Asn | His  |  |
| 930  |     |     |     |     | 935  |     |     |     |     | 940  |     |     |     |     |      |  |
| Ala  | Leu | Cys | Asn | Asn | Lys  | Leu | Tyr | Leu | Asp | Ile  | Leu | Lys | Val | Leu | Lys  |  |
| 945  |     |     |     |     | 950  |     |     |     |     | 955  |     |     |     |     | 960  |  |
| His  | Leu | Lys | Thr | Phe | Phe  | Asn | Leu | Asp | Asn | Ile  | Asp | Thr | Ala | Leu | Thr  |  |
| 965  |     |     |     |     | 970  |     |     |     |     | 975  |     |     |     |     |      |  |
| Leu  | Tyr | Met | Asn | Leu | Pro  | Met | Leu | Phe | Gly | Gly  | Gly | Asp | Pro | Asn | Leu  |  |
| 980  |     |     |     |     | 985  |     |     |     |     | 990  |     |     |     |     |      |  |
| Leu  | Tyr | Arg | Ser | Phe | Tyr  | Arg | Arg | Thr | Pro | Asp  | Phe | Leu | Thr | Glu | Ala  |  |
| 995  |     |     |     |     | 1000 |     |     |     |     | 1005 |     |     |     |     |      |  |
| Ile  | Val | His | Ser | Val | Phe  | Ile | Leu | Ser | Tyr | Tyr  | Thr | Asn | His | Asp | Leu  |  |
| 1010 |     |     |     |     | 1015 |     |     |     |     | 1020 |     |     |     |     |      |  |
| Lys  | Asp | Lys | Leu | Gln | Asp  | Leu | Ser | Asp | Asp | Arg  | Leu | Asn | Lys | Phe | Leu  |  |
| 1025 |     |     |     |     | 1030 |     |     |     |     | 1035 |     |     |     |     | 1040 |  |
| Thr  | Cys | Ile | Ile | Thr | Phe  | Asp | Lys | Asn | Pro | Asn  | Ala | Glu | Phe | Val | Thr  |  |
| 1045 |     |     |     |     | 1050 |     |     |     |     | 1055 |     |     |     |     |      |  |
| Leu  | Met | Arg | Asp | Pro | Gln  | Ala | Leu | Gly | Ser | Glu  | Arg | Gln | Ala | Lys | Ile  |  |
| 1060 |     |     |     |     | 1065 |     |     |     |     | 1070 |     |     |     |     |      |  |
| Thr  | Ser | Glu | Ile | Asn | Arg  | Leu | Ala | Val | Thr | Glu  | Val | Leu | Ser | Thr | Ala  |  |
| 1075 |     |     |     |     | 1080 |     |     |     |     | 1085 |     |     |     |     |      |  |
| Pro  | Asn | Lys | Ile | Phe | Ser  | Lys | Ser | Ala | Gln | His  | Tyr | Thr | Thr | Thr | Glu  |  |
| 1090 |     |     |     |     | 1095 |     |     |     |     | 1100 |     |     |     |     |      |  |
| Ile  | Asp | Leu | Asn | Asp | Ile  | Met | Gln | Asn | Ile | Glu  | Pro | Thr | Tyr | Pro | His  |  |
| 1105 |     |     |     |     | 1110 |     |     |     |     | 1115 |     |     |     |     | 1120 |  |
| Gly  | Leu | Arg | Val | Val | Tyr  | Glu | Ser | Leu | Pro | Phe  | Tyr | Lys | Ala | Glu | Lys  |  |
| 1125 |     |     |     |     | 1130 |     |     |     |     | 1135 |     |     |     |     |      |  |
| Ile  | Val | Asn | Leu | Ile | Ser  | Gly | Thr | Lys | Ser | Ile  | Thr | Asn | Ile | Leu | Glu  |  |

|   |      |      |      |      |      |
|---|------|------|------|------|------|
|   | 1140 |      | 1145 |      | 1150 |
| Lys Thr Ser Ala Ile Asp Leu Thr Asp Ile Asp Arg Ala Thr Glu Met |      |      |      |      |      |
|   | 1155 |      | 1160 |      | 1165 |
| Met Arg Lys Asn Ile Thr Leu Leu Ile Arg Ile Leu Pro Leu Asp Cys |      |      |      |      |      |
|   | 1170 |      | 1175 |      | 1180 |
| Asn Arg Asp Lys Arg Glu Ile Leu Ser Met Glu Asn Leu Ser Ile Thr |      |      |      |      |      |
| 1185  |      | 1190 |      | 1195 | 1200 |
| Glu Leu Ser Lys Tyr Val Arg Glu Arg Ser Trp Ser Leu Ser Asn Ile |      |      |      |      |      |
|   | 1205 |      | 1210 |      | 1215 |
| Val Gly Val Thr Ser Pro Ser Ile Met Tyr Thr Met Asp Ile Lys Tyr |      |      |      |      |      |
|   | 1220 |      | 1225 |      | 1230 |
| Thr Thr Ser Thr Ile Ser Ser Gly Ile Ile Ile Glu Lys Tyr Asn Val |      |      |      |      |      |
|   | 1235 |      | 1240 |      | 1245 |
| Asn Ser Leu Thr Arg Gly Glu Arg Gly Pro Thr Lys Pro Trp Val Gly |      |      |      |      |      |
|   | 1250 |      | 1255 |      | 1260 |
| Ser Ser Thr Gln Glu Lys Lys Thr Met Pro Val Tyr Asn Arg Gln Val |      |      |      |      |      |
| 1265  |      | 1270 |      | 1275 | 1280 |
| Leu Thr Lys Lys Gln Arg Asp Gln Ile Asp Leu Leu Ala Lys Leu Asp |      |      |      |      |      |
|   | 1285 |      | 1290 |      | 1295 |
| Trp Val Tyr Ala Ser Ile Asp Asn Lys Asp Glu Phe Met Glu Glu Leu |      |      |      |      |      |
|   | 1300 |      | 1305 |      | 1310 |
| Ser Ile Gly Thr Leu Gly Leu Thr Tyr Glu Lys Ala Lys Lys Leu Phe |      |      |      |      |      |
|   | 1315 |      | 1320 |      | 1325 |
| Pro Gln Tyr Leu Ser Val Asn Tyr Leu His Arg Leu Thr Val Ser Ser |      |      |      |      |      |
|   | 1330 |      | 1335 |      | 1340 |
| Arg Pro Cys Glu Phe Pro Ala Ser Ile Pro Ala Tyr Arg Thr Thr Asn |      |      |      |      |      |
| 1345  |      | 1350 |      | 1355 | 1360 |
| Tyr His Phe Asp Thr Ser Pro Ile Asn Arg Ile Leu Thr Glu Lys Tyr |      |      |      |      |      |
|   | 1365 |      | 1370 |      | 1375 |
| Gly Asp Glu Asp Ile Asp Ile Val Phe Gln Asn Cys Ile Ser Phe Gly |      |      |      |      |      |
|   | 1380 |      | 1385 |      | 1390 |
| Leu Ser Leu Met Ser Val Val Glu Gln Phe Thr Asn Val Cys Pro Asn |      |      |      |      |      |
|   | 1395 |      | 1400 |      | 1405 |
| Arg Ile Ile Leu Ile Pro Lys Leu Asn Glu Ile His Leu Met Lys Pro |      |      |      |      |      |
|   | 1410 |      | 1415 |      | 1420 |
| Pro Ile Phe Thr Gly Asp Val Asp Ile His Lys Leu Lys Gln Val Ile |      |      |      |      |      |
| 1425  |      | 1430 |      | 1435 | 1440 |
| Gln Lys Gln His Met Phe Leu Pro Asp Lys Ile Ser Leu Thr Gln Tyr |      |      |      |      |      |
|   | 1445 |      | 1450 |      | 1455 |
| Val Glu Leu Phe Leu Ser Asn Lys Thr Leu Lys Ser Gly Ser His Val |      |      |      |      |      |
|   | 1460 |      | 1465 |      | 1470 |
| Asn Ser Asn Leu Ile Leu Ala His Lys Ile Ser Asp Tyr Phe His Asn |      |      |      |      |      |
|   | 1475 |      | 1480 |      | 1485 |
| Thr Tyr Ile Leu Ser Thr Asn Leu Ala Gly His Trp Ile Leu Ile Ile |      |      |      |      |      |
|   | 1490 |      | 1495 |      | 1500 |
| Gln Leu Met Lys Asp Ser Lys Gly Ile Phe Glu Lys Asp Trp Gly Glu |      |      |      |      |      |
| 1505  |      | 1510 |      | 1515 | 1520 |
| Gly Tyr Ile Thr Asp His Met Phe Ile Asn Leu Lys Val Phe Phe Asn |      |      |      |      |      |
|   | 1525 |      | 1530 |      | 1535 |
| Ala Tyr Lys Thr Tyr Leu Leu Cys Phe His Lys Gly Tyr Gly Lys Ala |      |      |      |      |      |
|   | 1540 |      | 1545 |      | 1550 |
| Lys Leu Glu Cys Asp Met Asn Thr Ser Asp Leu Leu Cys Val Leu Glu |      |      |      |      |      |
|   | 1555 |      | 1560 |      | 1565 |
| Leu Ile Asp Ser Ser Tyr Trp Lys Ser Met Ser Lys Val Phe Leu Glu |      |      |      |      |      |
|   | 1570 |      | 1575 |      | 1580 |
| Gln Lys Val Ile Lys Tyr Ile Leu Ser Gln Asp Ala Ser Leu His Arg |      |      |      |      |      |
| 1585  |      | 1590 |      | 1595 | 1600 |
| Val Lys Gly Cys His Ser Phe Lys Leu Trp Phe Leu Lys Arg Leu Asn |      |      |      |      |      |

|     |     |     |     |     |      |     |     |     |     |      |     |     |     |     |      |
|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|------|-----|-----|-----|-----|------|
|     |     |     |     |     | 1605 |     |     |     |     | 1610 |     |     |     |     | 1615 |
| Val | Ala | Glu | Phe | Thr | Val  | Cys | Pro | Trp | Val | Val  | Asn | Ile | Asp | Tyr | His  |
|     |     |     |     |     | 1620 |     |     |     |     | 1625 |     |     |     |     | 1630 |
| Pro | Thr | His | Met | Lys | Ala  | Ile | Leu | Thr | Tyr | Ile  | Asp | Leu | Val | Arg | Met  |
|     |     |     |     |     | 1635 |     |     |     |     | 1640 |     |     |     |     | 1645 |
| Gly | Leu | Ile | Asn | Ile | Asp  | Arg | Ile | His | Ile | Lys  | Asn | Lys | His | Lys | Phe  |
|     |     |     |     |     | 1650 |     |     |     |     | 1655 |     |     |     |     | 1660 |
| Asn | Asp | Glu | Phe | Tyr | Thr  | Ser | Asn | Leu | Phe | Tyr  | Ile | Asn | Tyr | Asn | Phe  |
|     |     |     |     |     | 1665 |     |     |     |     | 1670 |     |     |     |     | 1675 |
| Ser | Asp | Asn | Thr | His | Leu  | Leu | Thr | Lys | His | Ile  | Arg | Ile | Ala | Asn | Ser  |
|     |     |     |     |     | 1685 |     |     |     |     | 1690 |     |     |     |     | 1695 |
| Glu | Leu | Glu | Asn | Asn | Tyr  | Asn | Lys | Leu | Tyr | His  | Pro | Thr | Pro | Glu | Thr  |
|     |     |     |     |     | 1700 |     |     |     |     | 1705 |     |     |     |     | 1710 |
| Leu | Glu | Asn | Ile | Leu | Ala  | Asn | Pro | Ile | Lys | Ser  | Asn | Asp | Lys | Lys | Thr  |
|     |     |     |     |     | 1715 |     |     |     |     | 1720 |     |     |     |     | 1725 |
| Leu | Asn | Asp | Tyr | Cys | Ile  | Gly | Lys | Asn | Val | Asp  | Ser | Ile | Met | Leu | Pro  |
|     |     |     |     |     | 1730 |     |     |     |     | 1735 |     |     |     |     | 1740 |
| Leu | Leu | Ser | Asn | Lys | Lys  | Leu | Ile | Lys | Ser | Ser  | Ala | Met | Ile | Arg | Thr  |
|     |     |     |     |     | 1745 |     |     |     |     | 1750 |     |     |     |     | 1755 |
| Asn | Tyr | Ser | Lys | Gln | Asp  | Leu | Tyr | Asn | Leu | Phe  | Pro | Met | Val | Val | Ile  |
|     |     |     |     |     | 1765 |     |     |     |     | 1770 |     |     |     |     | 1775 |
| Asp | Arg | Ile | Ile | Asp | His  | Ser | Gly | Asn | Thr | Ala  | Lys | Ser | Asn | Gln | Leu  |
|     |     |     |     |     | 1780 |     |     |     |     | 1785 |     |     |     |     | 1790 |
| Tyr | Thr | Thr | Thr | Ser | His  | Gln | Ile | Ser | Leu | Val  | His | Asn | Ser | Thr | Ser  |
|     |     |     |     |     | 1795 |     |     |     |     | 1800 |     |     |     |     | 1805 |
| Leu | Tyr | Cys | Met | Leu | Pro  | Trp | His | His | Ile | Asn  | Arg | Phe | Asn | Phe | Val  |
|     |     |     |     |     | 1810 |     |     |     |     | 1815 |     |     |     |     | 1820 |
| Phe | Ser | Ser | Thr | Gly | Cys  | Lys | Ile | Ser | Ile | Glu  | Tyr | Ile | Leu | Lys | Asp  |
|     |     |     |     |     | 1825 |     |     |     |     | 1830 |     |     |     |     | 1835 |
| Leu | Lys | Ile | Lys | Asp | Pro  | Asn | Cys | Ile | Ala | Phe  | Ile | Gly | Glu | Gly | Ala  |
|     |     |     |     |     | 1845 |     |     |     |     | 1850 |     |     |     |     | 1855 |
| Gly | Asn | Leu | Leu | Leu | Arg  | Thr | Val | Val | Glu | Leu  | His | Pro | Asp | Ile | Arg  |
|     |     |     |     |     | 1860 |     |     |     |     | 1865 |     |     |     |     | 1870 |
| Tyr | Ile | Tyr | Arg | Ser | Leu  | Lys | Asp | Cys | Asn | Asp  | His | Ser | Leu | Pro | Ile  |
|     |     |     |     |     | 1875 |     |     |     |     | 1880 |     |     |     |     | 1885 |
| Glu | Phe | Leu | Arg | Leu | Tyr  | Asn | Gly | His | Ile | Asn  | Ile | Asp | Tyr | Gly | Glu  |
|     |     |     |     |     | 1890 |     |     |     |     | 1895 |     |     |     |     | 1900 |
| Asn | Leu | Thr | Ile | Pro | Ala  | Thr | Asp | Ala | Thr | Asn  | Asn | Ile | His | Trp | Ser  |
|     |     |     |     |     | 1905 |     |     |     |     | 1910 |     |     |     |     | 1915 |
| Tyr | Leu | His | Ile | Lys | Phe  | Ala | Glu | Pro | Ile | Ser  | Leu | Phe | Val | Cys | Asp  |
|     |     |     |     |     | 1925 |     |     |     |     | 1930 |     |     |     |     | 1935 |
| Ala | Glu | Leu | Ser | Val | Thr  | Val | Asn | Trp | Ser | Lys  | Ile | Ile | Ile | Glu | Trp  |
|     |     |     |     |     | 1940 |     |     |     |     | 1945 |     |     |     |     | 1950 |
| Ser | Lys | His | Val | Arg | Lys  | Cys | Lys | Tyr | Cys | Ser  | Ser | Val | Asn | Lys | Cys  |
|     |     |     |     |     | 1955 |     |     |     |     | 1960 |     |     |     |     | 1965 |
| Met | Leu | Ile | Val | Lys | Tyr  | His | Ala | Gln | Asp | Asp  | Ile | Asp | Phe | Lys | Leu  |
|     |     |     |     |     | 1970 |     |     |     |     | 1975 |     |     |     |     | 1980 |
| Asp | Asn | Ile | Thr | Ile | Leu  | Lys | Thr | Tyr | Val | Cys  | Leu | Gly | Ser | Lys | Leu  |
|     |     |     |     |     | 1985 |     |     |     |     | 1990 |     |     |     |     | 1995 |
| Lys | Gly | Ser | Glu | Val | Tyr  | Leu | Val | Leu | Thr | Ile  | Gly | Pro | Ala | Asn | Ile  |
|     |     |     |     |     | 2005 |     |     |     |     | 2010 |     |     |     |     | 2015 |
| Phe | Pro | Val | Phe | Asn | Val  | Val | Gln | Asn | Ala | Lys  | Leu | Ile | Leu | Ser | Arg  |
|     |     |     |     |     | 2020 |     |     |     |     | 2025 |     |     |     |     | 2030 |
| Thr | Lys | Asn | Phe | Ile | Met  | Pro | Lys | Lys | Ala | Asp  | Lys | Glu | Ser | Ile | Asp  |
|     |     |     |     |     | 2035 |     |     |     |     | 2040 |     |     |     |     | 2045 |
| Ala | Asn | Ile | Lys | Ser | Leu  | Ile | Pro | Phe | Leu | Cys  | Tyr | Pro | Ile | Thr | Lys  |
|     |     |     |     |     | 2050 |     |     |     |     | 2055 |     |     |     |     | 2060 |
| Lys | Gly | Ile | Asn | Thr | Ala  | Leu | Ser | Lys | Leu | Lys  | Ser | Val | Val | Ser | Gly  |

|   |      |      |      |
|---|------|------|------|
| 2065  | 2070 | 2075 | 2080 |
| Asp Ile Leu Ser Tyr Ser Ile Ala Gly Arg Asn Glu Val Phe Ser Asn |      |      |      |
|   | 2085 | 2090 | 2095 |
| Lys Leu Ile Asn His Lys His Met Asn Ile Leu Lys Trp Phe Asn His |      |      |      |
|   | 2100 | 2105 | 2110 |
| Val Leu Asn Phe Arg Ser Thr Glu Leu Asn Tyr Asn His Leu Tyr Met |      |      |      |
|   | 2115 | 2120 | 2125 |
| Val Glu Ser Thr Tyr Pro Tyr Leu Ser Glu Leu Leu Asn Ser Leu Thr |      |      |      |
|   | 2130 | 2135 | 2140 |
| Thr Asn Glu Leu Lys Lys Leu Ile Lys Ile Thr Gly Ser Leu Leu Tyr |      |      |      |
| 2145  | 2150 | 2155 | 2160 |
| Asn Phe His Asn Glu   |      |      |      |
|   | 2165 |      |      |

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